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P. . ENT COOPERATION TREA

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

To:

United States Patent and Trademark Office
(Box PCT)
Crystal Plaza 2
Washington, DC 20231
ETATS-UNIS D'AMERIQUE

in its capacity as elected Office

Date of mailing (day/month/year) 20 August 1998 (20.08.98)	
International application No. PCT/NZ97/00168	**Applicant's or agent's file reference** MH501578-142
International filing date (day/month/year) 12 December 1997 (12.12.97)	**Priority date** (day/month/year) 12 December 1996 (12.12.96)
Applicant HOUGHTON, Bradley et al	

1. The designated Office is hereby notified of its election made:

[X] in the demand filed with the International Preliminary Examining Authority on:

26 June 1998 (26.06.98)

[ ] in a notice effecting later election filed with the International Bureau on:

2. The election [X] was

[ ] was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO **34, chemin des Colombettes** **1211 Geneva 20, Switzerland**	Authorized officer J. Leitao
Facsimile No.: (41-22) 740.14.35	Telephone No.: (41-22) 338.83.38

Form PCT/IB/331 (July 1992)

2195500

ATENT COOPERATION TREA

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INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference MH 501578-142	**FOR FURTHER ACTION**	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416).
International application No. **PCT/NZ 97/00168**	International filing date *(day/month/year)* 12 December 1997	Priority Date *(day/month/year)* 12 December 1996

International Patent Classification (IPC) or national classification and IPC

Int. Cl.[6] G05D 23/12

Applicant

THE UNIQUE COMPANY LIMITED et al

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of **5** sheets, including this cover sheet.

[X] This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of **10** sheet(s).

3. This report contains indications relating to the following items:

I	[X]	Basis of the report
II	[ ]	Priority
III	[X]	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
IV	[ ]	Lack of unity of invention
V	[X]	Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
VI	[ ]	Certain documents cited
VII	[ ]	Certain defects in the international application
VIII	[X]	Certain observations on the international application

Date of submission of the demand 26 June 1998	Date of completion of the report 12 March 1999
Name and mailing address of the IPEA/AU AUSTRALIAN PATENT OFFICE PO BOX 200 WODEN ACT 2606 AUSTRALIA Facsimile No. (02) 6285 3929	Authorized Officer **DEREK BARNES** Telephone No. (02) 6283 2198

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/NZ 97/00168

I. Basis of the report

1. With regard to the **elements** of the international application:*

☐ the international application as originally filed.

☒ the description, pages **, 1-17** as originally filed,
pages , filed with the demand,
pages , filed with the letter of .

☒ the claims, pages , as originally filed,
pages , as amended (together with any statement) under Article 19,
pages , filed with the demand,
pages **, 18-23** filed with the letter of \7 **February 1999.**

☒ the drawings, pages **, 5-8** as originally filed,
pages , filed with the demand,
pages **, 1-4** filed with the letter of \7 **February 1999.**

☐ the sequence listing part of the description:
pages , as originally filed
pages , filed with the demand
pages , filed with the letter of

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.
These elements were available or furnished to this Authority in the following language which is:

☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).

☐ the language of publication of the international application (under Rule 48.3(b)).

☐ the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, was on the basis of the sequence listing:

☐ contained in the international application in written form.

☐ filed together with the international application in computer readable form.

☐ furnished subsequently to this Authority in written form.

☐ furnished subsequently to this Authority in computer readable form.

☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

4. ☐ The amendments have resulted in the cancellation of:
☐ the description, pages
☐ the claims, Nos.
☐ the drawings, sheets/fig

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).**

* *Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).*

** *Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report*

III. Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

1. The questions whether the claimed invention appears to be novel, to involve an inventive step (to be nonobvious), or to be industrially applicable have not been examined in respect of:

☐ the entire international application,

☒ claims Nos.: **30-32**

because:

☐ the said international application, or the said claims Nos. relate to the following subject matter which does not require an international preliminary examination *(specify)*:

☒ the description, claims or drawings *(indicate particular elements below)* or said claims Nos. **30-32** are so unclear that no meaningful opinion could be formed *(specify)*:

It is impossible to determine from omnibus claims 30-32 what features are being defined by these claims. Therefore no meaningful opinion could be formed on the novelty, inventive step or industrial applicability of these claims.

☐ the claims, or said claims Nos. are so inadequately supported by the description that no meaningful opinion could be formed.

☐ no international search report has been established for said claim Nos.

2. A meaningful international preliminary examination cannot be carried out due to the failure of the nucleotide and/or amino acid sequence listing to comply with the standard provided for in Annex C of the Administrative Instructions:

☐ the written form has not been furnished or does not comply with the standard.

☐ the computer readable form has not been furnished or does not comply with the standard.

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	1-29	YES
	Claims		NO
Inventive step (IS)	Claims	1-29	YES
	Claims		NO
Industrial applicability (IA)	Claims	1-29	YES
	Claims		NO

2. Citations and explanations (Rule 70.7)

NOTE: I have examined the novelty and inventive step of amended claims 1-29. Please note however that the search was conducted only on original claims 1-6 and 14 and that there may be other citations against the features disclosed in original claims 7-13 and 15-28 not identified here.

CITATIONS

(a) US 3363536 A (DEAN) 16 January 1968, see whole document.

(b) US 3810602 A (PARKINSON) 14 May 1974, see whole document.

(c) US 5417083 A (EBER) 23 May 1995, see whole document..

NOVELTY (N) AND INVENTIVE STEP (IS)

None of the citations in the International Search Report, or obvious combination of these citations, disclose the features of, a mixing valve including two fluid supplies communicating with two first apertures of a first disk member, a second disk member with apertures and wherein the disk members are variably alignable in a coaxial constrained manner to vary fluid flow through the apertures. Therefore claims 1-29 are novel and involve an inventive step.

INDUSTRIAL APPLICABILITY (IA)

Claims 1-29 are clearly applicable to the fluid control or plumbing industries.

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

(6) Claim 5 is not clear because I cannot find an antecedent to "the at least one friction reducing region" when the claim is appended to Claim 3.

(7) Claim 15 is not clear because it is not clear from the claim where the "two fluid supplies" are connected in the apparatus.

(8). Claims 16-28 are not clear because they each appear to be appended to the wrong claims, some examples are the following:.

(a) Claim 16 which refers to "the at least one electric motor" is appended to claims 13 or 14 but claim 13 does not define at least one electric motor. Possibly claim 16 should be appended to claims 14 or 15.

(b) Claim 18 which refers to "the at least one electric motor" is appended to any one of claims 13 to 16 but claim13 does not define at least one electric motor. Possibly claim 18 should be appended to any one of claims 14 to 17.

(c) Claim 19 which refers to "the controller" is appended to claim 17 but claim 17 does not define a controller. Possibly claim 19 should be appended to claim 18.

(d) Claim 21 which refers to "the at least one sensor" and "the at least one parameter" is appended to claim 19 but claim 19 does not define at least on sensor and at least one parameter. Possibly claim 21 should be appended to claim 20.

(e) Claim 22 which refers to "the at least one given parameter" is appended to claim 19 or 20 but claim 19 does not define at least one parameter. Possibly claim 22 should be appended to claims 20 or 21.

(f) Claim 23 which refers to "the controller" is appended to any one of claims 17 to 21 but claim 17 does not define a controller. Possibly claim 23 should be appended to any one of claims 18 to 22.

(g) Claims 25 which refers to the manifold outlets is appended to claim 23 but claim 23 does not define manifold outlets. Possibly claim 25 should be appended to claim 24.

(h) Claim 26 which refers to the at least one parameter is appended to any one of claims 19 to 24 but claim 19 does not define at least one parameter. Possibly claim 26 should be appended to any one of claims 20 to 25.

This objection might also apply to some of claims 2 to 14.

(9) Claims 30-32 are not clear because it is not clear from each claim what essential features are defined by that claim ie. it is not clear what constitutes a valve assembly, a servo valve system or a combined mixing and diverting valve.

CLAIMS

1) A fluid control/mixing valve including:

- a valve body;
- a first disk member defining at least two first apertures communicating with at least two corresponding fluid supplies or outlets;
- a second disk member defining at least one second aperture;
- wherein the first and second disk members are arranged in sealing contact and are variably alignable in a coaxial, constrained manner, so that the first and second apertures are, in turn, variably alignable such that fluid may flow through the at least two first apertures only when there is an overlap between first and second apertures, and such that the flow through the or each second aperture may be varied by variable coaxial alignment of the first and second apertures.

2) A fluid control/mixing valve as claimed in Claim 1 wherein the torque between the first and second disk members is such that their relative coaxial rotation may be effected by means of a stepper motor, DC motor or the like.

3) A fluid control valve as claimed in Claim 1, wherein the first disk member includes at least one sealing region suitable to facilitate sealing between the first and second disk members.

4) A fluid control valve as claimed in Claim 2, wherein the first disk member includes at least one friction reducing region consisting of an indented region to reduce the area of contact between the first and second disk members.

5) A fluid control valve as claimed in Claim 3, wherein the at least one friction reducing region is substantially defined by a sealing region arranged around the periphery of the first disk member.

6) A fluid control valve as claimed in Claim 4, wherein the at least one friction reducing region includes at least one region extending radially to the periphery of the first member.

7) A fluid control valve as claimed in any one of the preceding claims, wherein the or each first aperture is substantially sector shaped.

8) A fluid control valve as claimed in any one of the preceding claims, wherein the or each second aperture is substantially sector shaped.

9) A valve as claimed in any one of the preceding claims, wherein the valve is arranged such that variable alignment of the first and second disk members is brought about by relative rotation of the first and second members.

10) A valve as claimed in Claim 8, wherein the second disk member is rotatable within a cylindrical region.

11) A valve as claimed in any one of the preceding claims, wherein the second disk member is substantially in the form of a disk having one or more removed sector(s).

12) A valve as claimed in any one of the preceding claims, wherein the first disk member is substantially of the form of a disk having at least one removed interior region.

13) A valve as claimed in any one of the preceding claims including a pipe having an internal bore into which the first disk member sealingly fits such that fluid is constrained to passing only through the inlet apertures.

14) A valve as claimed in any one of the preceding claims including at least one electric motor arranged to actuate the relative alignment of the first and second disk members.

15) A fluid control/mixing valve communicating with at least two fluid supplies, including:

- at least two valve subunits, each subunit including a first disk member having at least one first apertures and a second disk member having at least second apertures, and leading to one outlet, and wherein fluid flow from the at least one first aperture is controllable by variable coaxial, constrained alignment of the first and second disk members;

- at least one electric motor arranged to actuate the variable alignment of first and second disk members for one or more valve subunits simultaneously and in a manner adapted to control and provide a specified fluid characteristic; and

- an outlet manifold having one or more manifold outlets.

16) A valve as claimed in Claims 13 or 14, wherein the at least one electric motor is a stepper motor.

17) A valve as claimed in any one of Claims 13 to 15, including at least one gear to facilitate the actuation for variable alignment of the first and second disk members.

18) A valve as claimed in any one of Claims 13 to 16 including a controller to control the at least one electric motor and thereby the flow from the or each of the first apertures.

19) A valve as claimed in Claim 17, wherein the controller includes a microcontroller.

20) A valve as claimed in Claim 17 or Claim 18, including at least one sensor to sense at least one parameter of the fluid(s).

21) A valve as claimed in Claim 19, wherein the controller is arranged to control the flow from the or each of the first apertures and to receive information from the at least one sensor to control at least one of the at least one parameter of fluid leaving the valve.

22) A valve as claimed in Claim 19 or Claim 20, wherein the at least one given parameter includes temperature information.

23) A valve as claimed in any one of Claims 17 to 21, wherein the controller is arranged suitably to estimate flow taking into account at least the position of the stepper motor.

24) A valve as claimed in any one of the preceding claims, including an outlet manifold having two or more manifold outlets.

25) A valve as claimed in Claim 23, wherein the one or more manifold outlets include valves to allow or prevent flow from the respective manifold outlets.

26) A valve as claimed in any one of Claims 19 to 24, including a user interface adapted to receive information on the at least one parameter of fluid leaving the valve.

27) A fluid control valve as claimed in any one of the preceding claims, including a single first aperture and at least two second apertures arranged such that variable alignment of the first and second members allows variable diversion of fluid through each of the at least two second apertures.

28) A fluid control valve including:

- at least two outlets;
- at least two fluid control valves as claimed in Claim 26, wherein one second aperture of each fluid control valve communicates with one or the other of the two outlets.

29) A valve as hereinbefore described with reference to any one of the embodiments shown in the accompanying drawings.

30) A valve assembly substantially as hereinbefore described with reference to any one of the embodiments shown in the accompanying drawings.

31) A servo valve system substantially as hereinbefore described with reference to any one of the embodiments shown in the accompanying drawings.

32) A combined mixing and diverting valve substantially as hereinbefore described with reference to Figures 17 to 20.

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File Ref: 501578-142

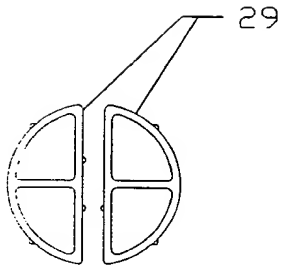


Figure 10

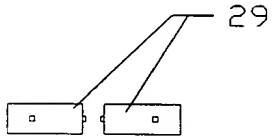


Figure 10a

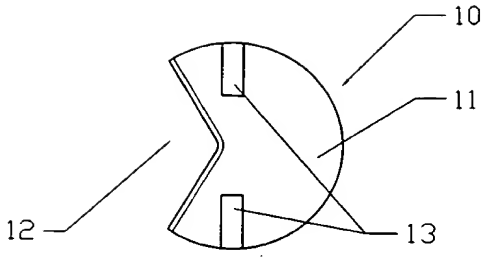


Figure 3

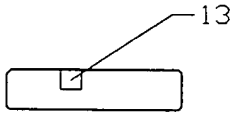


Figure 4

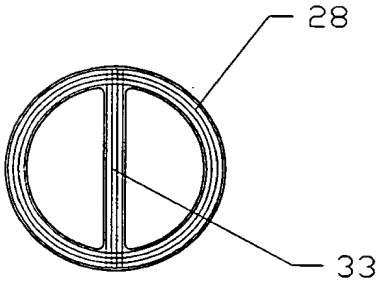


Figure 9

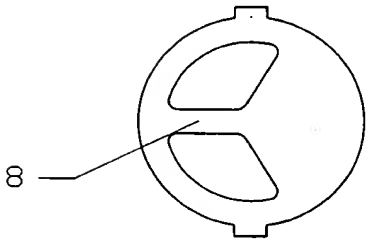


Figure 5

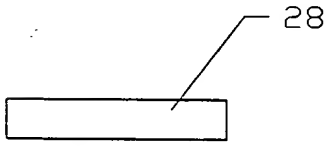


Figure 9a

Figure 6

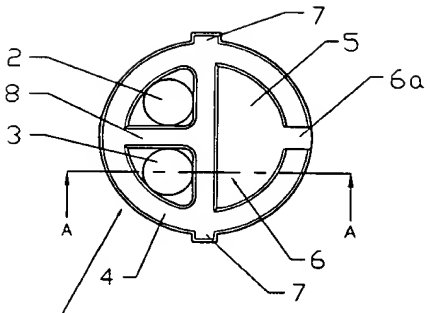


Figure 1

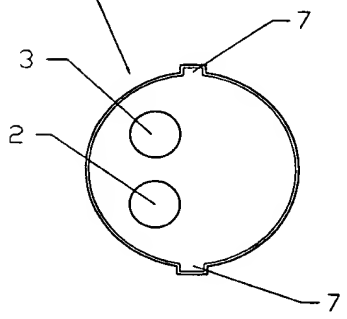
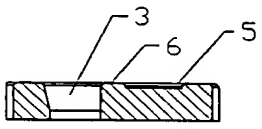


Figure 1a



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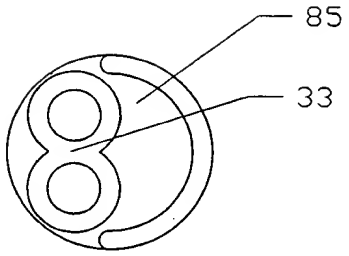


Figure 7

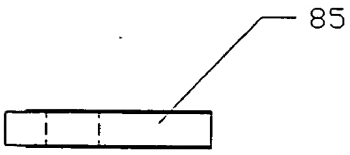


Figure 8

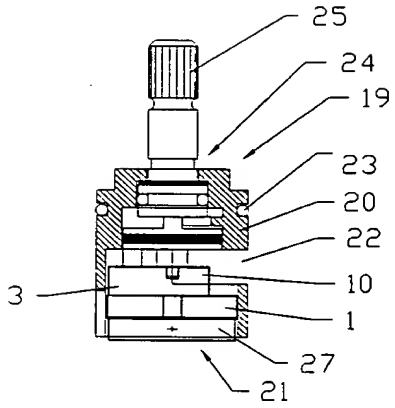


Figure 11

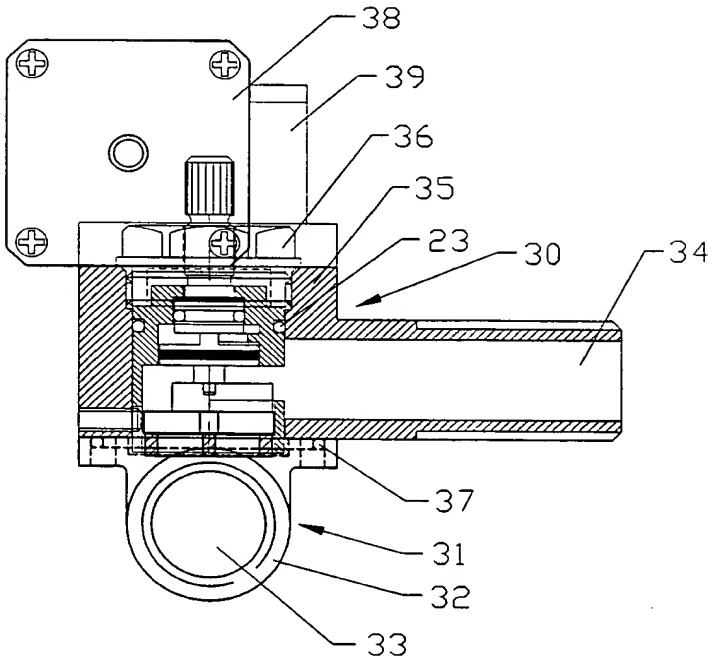
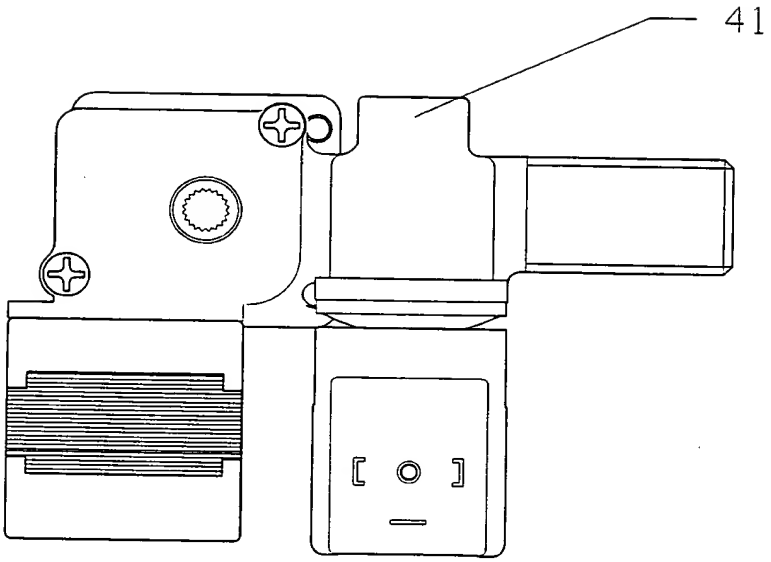
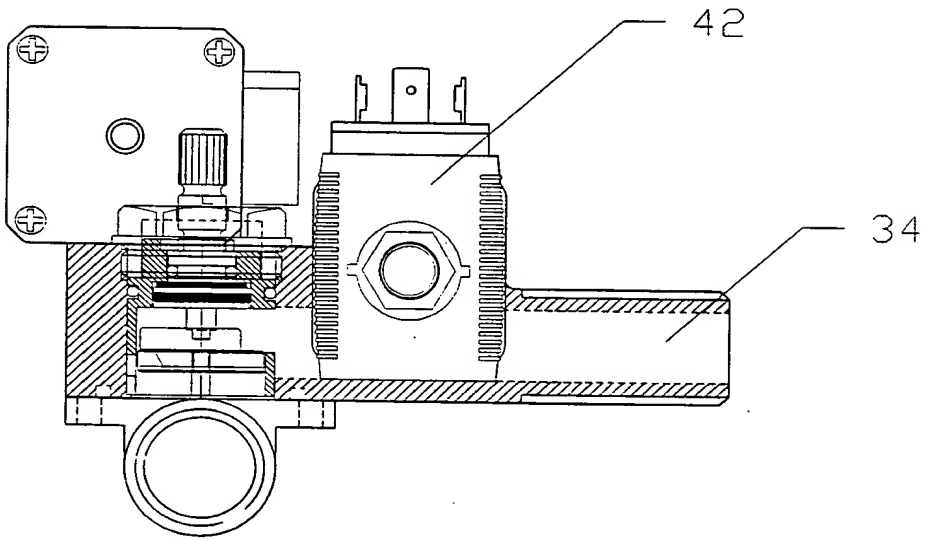


Figure 12

PCT/NZ97/00168
Received 17 February 1999





CLAIMS

1) A fluid control valve including:

- a valve body;
- a first member defining at least one first aperture communicating with at least one respective fluid supply or outlet;
- a second member defining at least one second aperture;
- wherein the first and second members are arranged in sealing contact and are variably alignable so that first and second apertures are, in turn, variably alignable such that fluid may flow through the at least one first aperture only when there is an overlap between first and second apertures, and such that the flow through the or each second aperture may be varied by variable alignment of the first and second apertures.

2) A fluid control valve as claimed in Claim 1, wherein the first member includes at least one sealing region suitable to facilitate sealing between the first and second members.

3) A fluid control valve as claimed in Claim 2, wherein the first member includes at least one friction reducing region consisting of an indented region to reduce the area of contact between the inlet and outlet members.

4) A fluid control valve as claimed in Claim 3, wherein the at least one friction reducing region is substantially defined by a sealing region arranged around the periphery of the first member.

5) A fluid control valve as claimed in Claim 4, wherein the at least one friction reducing region includes at least one region extending radially to the periphery of the inlet member.

6) A fluid control valve as claimed in any one of the preceding claims, wherein the or each first aperture is substantially sector shaped.

7) A fluid control valve as claimed in any one of the preceding claims, wherein the or each second aperture is substantially sector shaped.

8) A valve as claimed in any one of the preceding claims, wherein the valve is arranged such that variable alignment of the first and second members is brought about by relative rotation of the first and second members.

9) A valve as claimed in Claim 8, wherein the second member is rotatable within a cylindrical region.

10) A valve as claimed in any one of the preceding claims, wherein the second member is substantially in the form of a disk having one or more removed sector(s).

11) A valve as claim d in any one of the preceding claims, wherein the first member is substantially of the form of a disk having at least one

removed interior region.

12) A valve as claimed in any one of the preceding claims including a pipe having an internal bore into which the first member sealingly fits such that fluid is constrained to passing only through the inlet apertures.

13) A valve as claimed in any one of the preceding claims including at least one electric motor arranged to actuate the relative alignment of the first and second members.

14) A fluid control valve communicating with at least two fluid supplies, including:

- at least two valve subunits, each subunit including a first member having at least one first aperture and a second member having at least one second aperture, and wherein fluid flow from the at least one first aperture is controllable by variable alignment of the first and second members;

- at least one electric motor arranged to actuate the variable alignment of first and second members for one or more valve subunits.

15) A valve as claimed in Claims 13 or 14, wherein the at least one electric motor is a stepper motor.

16) A valve as claimed in any one of Claims 13 to 15, including at least one g ar to facilitate th actuation for variable alignment of the first and second members.

17) A valve as claimed in any one of Claims 13 to 16 including a controller to control the at least one electric motor and thereby the flow from the or each of the first apertures.

18) A valve as claimed in Claim 17, wherein the controller includes a microcontroller.

19) A valve as claimed in Claim 17 or Claim 18, including at least one sensor to sense at least one parameter of the fluid(s).

20) A valve as claimed in Claim 19, wherein the controller is arranged to control the flow from the or each of the first apertures and to receive information from the at least one sensor to control at least one of the at least one parameter of fluid leaving the valve.

21) A valve as claimed in Claim 19 or Claim 20, wherein the at least one given parameter includes temperature information.

22) A valve as claimed in any one of Claims 17 to 21, wherein the controller is arranged suitably to estimate flow taking into account at least the position of the stepper motor.

23) A valve as claimed in any one of the preceding claims, including an outlet manifold having two or more manifold outlets.

24) A valve as claimed in Claim 23, wherein the one or more manifold outlets include valves to allow or prevent flow from the respective manifold outlets.

25) A valve as claimed in any one of Claims 19 to 24, including a user interface adapted to receive information on the at least one parameter of fluid leaving the valve.

26) A fluid control valve as claimed in any one of the preceding claims, including a single first aperture and at least two second apertures arranged such that variable alignment of the first and second members allows variable diversion of fluid through each of the at least two second apertures.

27) A fluid control valve including:

- at least two outlets;
- at least two fluid control valves as claimed in Claim 26, wherein one second aperture of each fluid control valve communicates with one or the other of the two outlets.

28) A valve as hereinbefore described with reference to any one of the embodiments shown in the accompanying drawings.

29) A valve assembly substantially as hereinbefore described with reference to any one of the embodiments shown in the accompanying drawings.

30) A servo valve system substantially as hereinbefore described with reference to any one of the embodiments shown in the accompanying drawings.

31) A combined mixing and diverting valve substantially as hereinbefore described with reference to Figures 17 to 20.

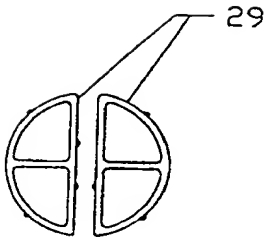


Figure 10

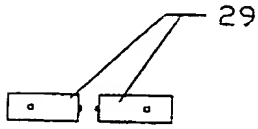


Figure 10a

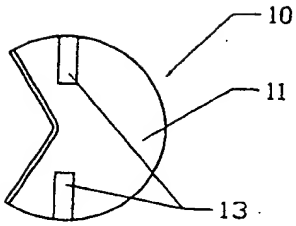


Figure 3

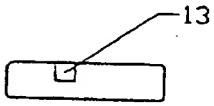


Figure 4

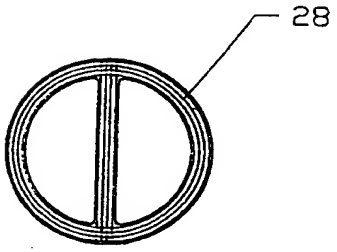


Figure 9

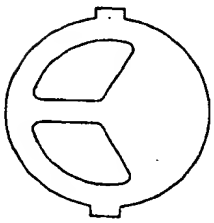


Figure 5

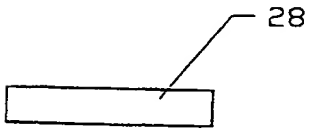
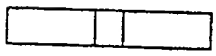


Figure 9a



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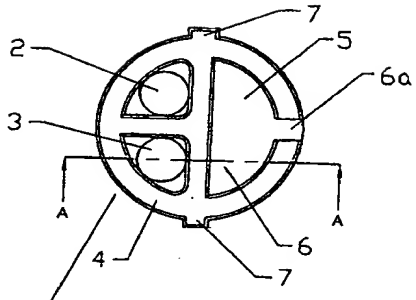

Figure 1

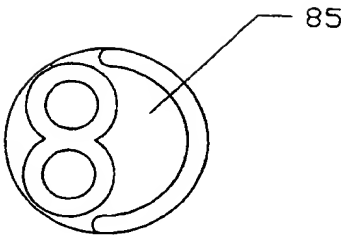

Figure 7

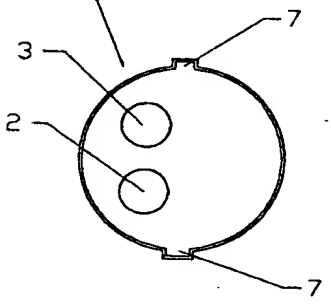

Figure 1a

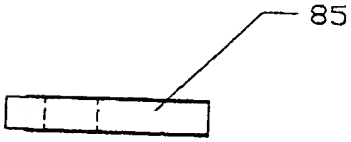

Figure 8

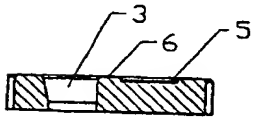

Figure 2

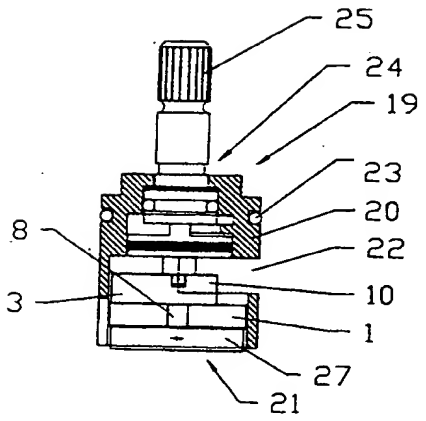

Figure 11

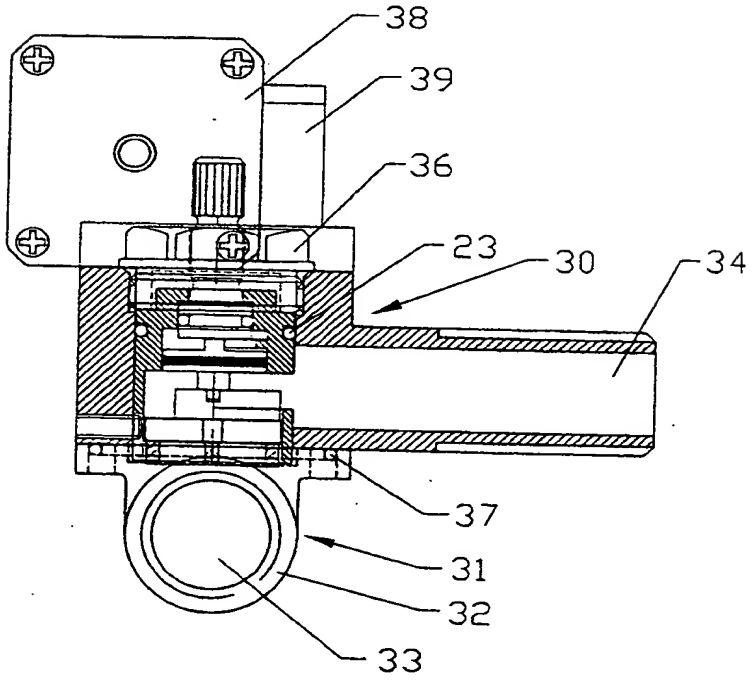

Figure 12

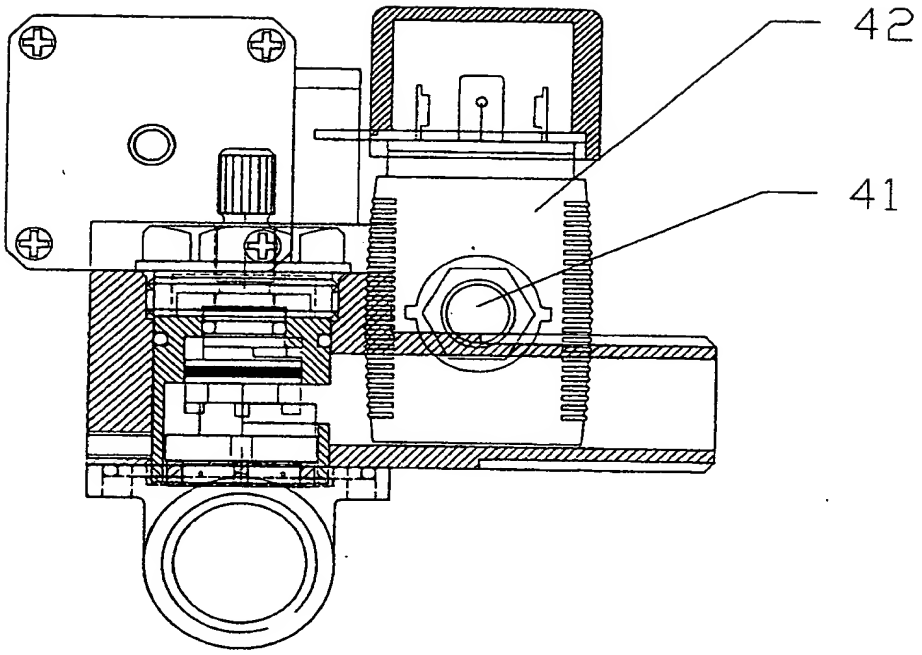

Figure 13

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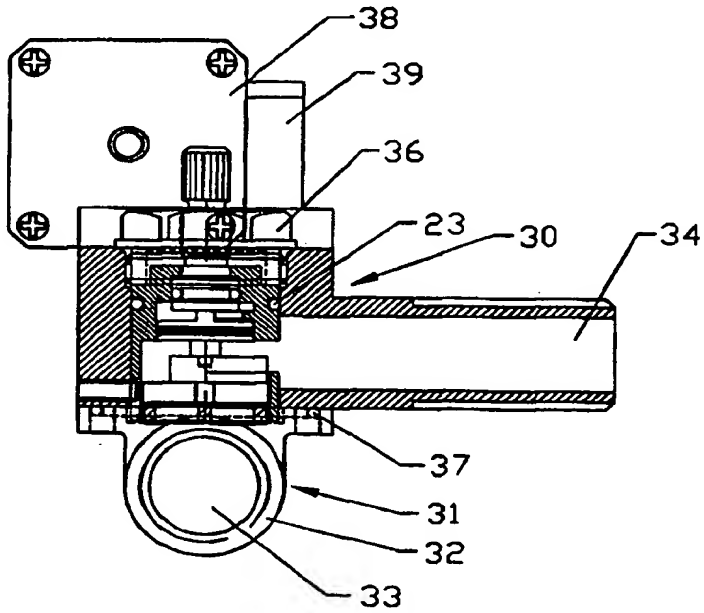
(57) Abstract

The present invention provides a mixing valve (30) suitable for electric motor (38) actuation, particularly stepper motor actuation. It also provides a servo mixing valve system, which includes stepper motors for actuation and optionally includes a solenoid switched outlet manifold and a combination mixing and dye. The present invention also provides an actively controlled bathroom shower mixing system including temperature formation feedback.



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VALVE SYSTEM FOR SERVO CONTROL OF FLUID FLOWS

The present invention relates to valves for controlling the flow of fluids in a fluid supply system. More particularly, it relates to valves suitable for active servo control of fluid flows. Further, in particular, it relates to valves for active servo control of fluid flows in a fluid mixing unit.

BACKGROUND OF THE INVENTION

Valve systems suitable for being electrically controlled and actuated are known for a wide variety of applications. These add the many advantages of control electronics and computing to their applications.

One such application, is the control of flow for shower mixers, hand basin mixers, and the like.

A commonly used conventional electrically controllable flow valve includes a conventional faucet valve and an electric motor to actuate the spindle of the faucet valve. The electric motor turns the spindle to axially move the disc of the faucet valve and restrict flow emerging from the disc ring of the faucet valve. Typically, multiple revolutions of the spindle are required to actuate the disk through its working range. Also the spindle is mounted and moved by means of a thread arrangement which introduces friction. Therefore, this type of valve is not well suited to servo control. Also, movement of the disk to close the valve must work against the supply pressure of the fluid.

Accordingly, it is an object of the present invention to provide a fluid control valve which overcomes or obviates the disadvantages of existing systems, or at least to provide the public with a useful choice.

It is also an object of an embodiment of the present invention to provide a fluid control valve adapted to servo control the flow of fluid through the valve, or at least to provide the public with a useful choice.

It is an object of an embodiment of the present invention to provide a servo controlled mixing of supplied fluids in given ratios, or at least to provide the public with a useful choice.

It is an object of an embodiment of the present invention to provide an actively controlled shower mixer which employs temperature feedback, or at least to provide the public with a useful choice.

SUMMARY OF THE INVENTION

According to an aspect of the present invention there is provided a valve body; a first member defining at least one first aperture communicating with at least one respective fluid supply or outlet; and a second member defining at least one second aperture; wherein the first and second members are arranged in sealing contact and are variably alignable so that first and second apertures are, in turn, variably alignable such that fluid may flow through the at least one first aperture only when there is an overlap between first and second apertures, and such that the flow through the or each second aperture may be varied by variable alignment of the first and second apertures.

Preferably, the first and second members are variably alignable by rotation. Preferably, this rotation may be actuated by a stepper motor which may be controlled by a controller including a microprocessor, preferably, receiving parameter feedback from at least one sensor.

According to another aspect of the present invention, there is provided a fluid control valve communicating with at least two fluid supplies, including:

- at least two valve subunits, each subunit including a first member having at least one first aperture and a second member having at least one second aperture, and wherein fluid flow from the at least one first aperture is controllable by variable alignment of the first and second members;

- at least one electric motor, preferably a stepper motor, arranged to actuate the variable alignment of first and second members for one or more valve subunits.

Preferably, the valve includes a controller including a microcontroller which may receive parameter feedback from at least one sensor.

According to another aspect of the present invention, there is provided a fluid control valve as claimed in any one of the preceding claims, including a single first aperture and at least two second apertures arranged such that variable alignment of the first and second members allows variable diversion of fluid through each of the at least two second apertures.

According to another aspect of the present invention, there is provided a fluid control valve including at least two outlets; at least two fluid control valves as immediately above, wherein one second aperture of each fluid control valve communicates with one or the other of the two outlets.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURES 1 & 1A: Respectively show top and bottom views of a part of a valve in accordance with an embodiment of the present invention.

FIGURE 2: Shows a side view of the part shown in Figures 1 and 1A.

FIGURE 3: Shows a plan view of another part of a valve according to the same embodiment of the present invention.

FIGURE 4: Shows a side view of the parts shown in Figure 3.

FIGURE 5: Shows a part of a valve corresponding to the parts shown in Figures 1 and 2 according to an alternative embodiment of the present invention.

FIGURE 6: Shows a side plan view of a part shown in Figure 5.

FIGURE 7: Shows a gasket which corresponds to the part of the valve shown in Figures 1, 1A and 2.

FIGURE 8: Shows a side view of the gasket shown in Figure 7.

FIGURES 9 & 9A: Shows part of a gasket used to seal either of the parts shown in Figures 1 and 2 or 5 and 6.

FIGURES 10 & 10A: Shows two reinforcement members for the gasket shown in Figure 9;

FIGURE 11: Shows a valve assembly incorporating the parts shown in Figures 1 to 10 of either embodiment.

FIGURE 12: Shows a servo valve system according to an embodiment of the present invention and incorporating the valve assembly shown in Figure 11.

FIGURE 13: Shows a servo valve system according to an alternative embodiment and incorporating the valve assembly shown in Figure 11.

FIGURE 14: Shows a servo valve system according to an alternative embodiment of the present invention.

FIGURE 15: Shows the layout of a user interface for a servo valve system according to an alternative embodiment of the present invention.

FIGURE 16: Schematically shows a mixing system according to an embodiment of the present invention.

FIGURES 17-20: Show a combination mixing and diverting servo valve system according to a further embodiment of the present invention.

DETAILED DESCRIPTION OF THE DRAWINGS

Figures 1 and 2 show an inlet valve member 1 which, in use, is aligned perpendicular to a flow of fluid through the valve. The inlet valve member 1 includes two conduits 2 and 3 through which fluid passes when the valve is open. Typically, these conduits have a cross section that is sectorial or elliptical at one face of the valve member 1 and circular at the other, although any suitable cross sectional shape may be substituted. The apertures are, typically, formed circular at the face of the inlet valve member 1 which is in contact with the fluid supply and the size of the circles are minimised, within constraints of required flow. In use, only the apertures and a minimal area around the apertures are in contact with the fluid supply to minimise pressure being exerted on the inlet valve member 1 which would increase friction between the inlet valve member 1 and the outlet valve member 10, described below. Also, typically, the conduits 2 and 3 are

positioned inward from the periphery of the valve member 1 to provide an area of the valve member 1 peripheral to the conduits against which another member may abut to seal the conduits 2 and 3 when required. However, suitable alternative sealing arrangements will be apparent to those skilled in the art.

The conduits 2 and 3 may have different relative sizes to account for relative differences in supply pressures or viscosity, for example.

The inlet valve member may typically have a recessed region 5 formed in the contact side 6 of the inlet valve member 1 and grooves 6a to reduce friction with any flat surface in contact with the contact side 6 of the inlet valve member 1. Such friction reduction measures reduce the actuation torque required by the valve. The edges of the inlet valve 1 may, typically, be bevelled to prevent chipping of the edges of the valve member 1.

The inlet valve member includes alignment tabs 7 with which it may be held in a given orientation.

Figures 3 and 4 show an output valve member 10. The valve member 10 has a contact surface 11 which may be flat so that the output valve member 10 may be sealingly abutted against the contact side of the inlet valve member 1 in use to seal the conduits 2 and 3 when required.

The output valve member 10 is of the form of a disk with a removed sector 12. It will be apparent to those skilled in the art that alternative shapes to a removed sector may suitably be substituted and that the shape may be optimised for particular applications. In use, the output valve member 10 is abutted and aligned with the inlet valve member 1 and depending on its orientation with respect thereto, variably impedes the flow of fluid emerging from the conduits 2 and 3. The flow will be completely impeded and the conduits 2 and 3 sealed when the cutout portion 12 of the output valve member 10 does not overlap either of the conduits 2 or 3. The flow of fluid through each of the conduits 2 and 3 can be varied from nil

flow to an unimpeded flow or a controlled ratio of flow through each conduit. Thus, the output valve member 10 and input valve member 1 may be combined to form a mixing valve. Alternatively, they may be reversed and combined to form a diverting valve. Alternatively, an inlet member having only one aperture may be used to control the flow of a single fluid, or both apertures of the inlet member 1 may communicate with a single fluid supply for the same purpose.

Typically, each conduit 2 and 3 communicates with a separate fluid supply conduit, not shown, and the output of the valve communicates with a single output conduit so that the valve allows the variable mixing of the fluids from the two supply conduits.

The output valve member 10 includes actuation recesses 13 by which it may be rotated.

The size of the cutout sector 12 in conjunction with the size of the apertures 2 and 3 determines the maximum flow rate for given fluids at given temperatures and pressures.

Figures 5 and 6 show an inlet valve member which includes conduits having a sectorial cross-section of greater area than those of the inlet valve member shown in Figures 1 and 2. It will be clear to those skilled in the art that other conduit sizes and shapes may be substituted as applicable to given applications of the valve.

Figures 7 and 8 show a seal, or gasket, 85 used in conjunction with the inlet valve member 1 shown in Figures 1, 1A and 2.

Figures 7 and 8 show a gasket 85 used to seal the inlet valve member 1 shown in Figures 1, 1A and 2.

Figures 9 to 12 show gasket elements 28 and 29, which are combined to form a gasket for sealing inlet valve members 1 shown in Figures 5 and 6. The gaskets are, typically, formed from silicon, rubber or

other suitable deformable material, and gasket members 29 are, typically, formed from plastic and serve the purpose of reinforcing the gasket member 28.

Figure 11 shows a valve assembly 19, including the inlet valve member 1 and outlet valve member 10 of either of the embodiments described above. These valve members are fitted inside a valve chassis 20. The cut-away sector 12 of the outlet valve member 10 and the valve chassis 20 define an outlet aperture. The valve chassis 20 is open at one end to form a valve chassis inlet 21. A valve chassis outlet 22 is formed in the side of the valve chassis 20. In use, the valve assembly 19 is fitted into a valve housing described below. An O-ring 23 is used to seal the valve assembly 19 in the valve housing.

The valve assembly 19 includes a spindle assembly 24, which engages the actuation recesses 13 of the outlet valve member 10. The outlet valve member 10 can be rotated by rotation of the spindle assembly 24, which includes a spline 25 formed at one end to facilitate turning of the spindle assembly 24.

The inlet valve member 1 is, typically, held in fixed alignment by the alignment tabs 7 which engage corresponding alignment recesses, not shown, in the valve assembly chassis 20. The spindle assembly 24 is sealed within the valve assembly chassis 20 by use of O-rings and washers.

The gasket 85 or that formed from gasket members 28 and 29 is fitted into the inlet end of the valve assembly chassis 20.

The working of the valve assembly is illustrated below with reference to hot and cold water, each being supplied by one separate conduit 2 or 3, as would be the case with an application such as a shower temperature control mixing valve.

The output valve member 10 is initially orientated so as to cover or seal both of the apertures 2 and 3 of the inlet valve member 1. The spindle

24 is then turned in an opening direction to initially uncover part of the aperture 2, for example, which is supplied with cold water. Continued turning in the same direction increasingly uncovers the aperture 2. Eventually, continued turning will uncover the other aperture 3 to which hot water is supplied and partially cover the aperture 2. The ratio of hot and cold water may be adjusted by turning the spindle 24 in the same direction or in the opposite direction. Having sectorial inlet and outlet apertures, provides that the valve has a linear flow response with respect to rotational angle.

At a mid point, equal portions of each aperture are uncovered and depending on the chosen shape and size of the conduits 2 and 3 and sector 12, this may correspond to partial covering of both apertures 2 and 3.

Further turning may result in only the aperture 3 being uncovered and only hot water being supplied to the valve assembly outlet 20.

Figure 12 shows a side view of a servo valve system 30, which includes the valve assembly described above.

The servo valve system 30 also includes an inlet manifold 31 having two inlets, one of which 32 is shown cross sectionally in Figure 13, and the other of which is positioned directly behind the dividing wall 33, as shown in Figure 13. The dividing piece 8 of the inlet valve member 1, which divides the two apertures 2 and 3 is aligned with the dividing wall 33. The gasket 26 is aligned accordingly. It may be preferable that the gasket 26 or the inlet manifold 31 are shaped like gasket 85 so that only the apertures of the inlet valve member 1 are in contact with the fluid supply as otherwise force exerted on the inlet valve member 1 causes increased friction between the inlet valve member 1 and the outlet valve member 10 which requires an increase actuation torque.

The servo valve system 30 includes an outlet pipe 34 connected at the outlet 22 of the valve assembly 19. Typically, but not necessarily, the outlet pipe 34 is integrally formed from the servo valve system housing 35.

The valve assembly 19 is secured in the housing 35 with an annular cap 36 and sealed at the top with the O-ring 23.

The inlet manifold 31 is sealed to the housing 35 with an O-ring 37.

The servo valve system 30 includes a stepper motor 38, or some other automated driving device such as a DC motor, AC motor or hydraulic motor, to actuate the spindle 24 at the spline 25 through a gear box 39. It will be apparent to those skilled in the art that a wide variety of stepper motors may be used with suitable gear boxes or that a spline 25 of suitable diameter may eliminate the need for a gearbox in some cases. By the use of the friction reducing measures described above, a minimally sized stepper motor may be used reducing the size and required resources of the device.

The servo valve system 30 may include one or more sensors, not shown, in the input manifold 31, but more particularly in the output pipe 34 to provide feedback for the control of the servo valve system 30.

The sensors may include temperature sensors. For example, a thermistor may be inserted through the side of the pipe 34 to monitor temperature of the water, say, in the outlet pipe and to allow suitable adjustment by the stepper motor 38 to control temperature of water in the outlet pipe 34 in the case where different temperature fluid supplies are connected to the inlet manifold 31.

Figure 13 shows a servo valve system 40 according to an alternative embodiment of the present invention. The servo valve system 40 differs from the servo valve system 30 described above, only by the inclusion of an extra output pipe 41 which may be opened or closed by way of a solenoid valve 42. In one application, the output pipe 34 supplies a hand held shower head and the output pipe 41 supplies a midriff height shower jet. The solenoid valve 42 opens and closes water supplied to the hand held shower head as desired.

Figure 14 shows a side view of a servo valve system 50 according to another aspect of the present invention.

The servo valve system 50 includes two individual valves such as 51 shown each being supplied by individual inlet pipes, such as 52 shown.

The valves consist of conventional apertured ceramic disks mounted in a chassis with two outlets on opposite sides of the chassis.

The ceramic disks each include two opposing apertures, typically sectorial in shape. To open the valve, one of the disks is rotated by way of the spindle so that the apertures of both disks overlap.

The outlets of both valve assemblies feed a single intermediary conduit 55. Each valve is actuated at the respective spline 54 of the respective spindle 53 by a gearbox respective 61 and a respective stepper motor 62.

As each valve controls the inflow of fluid from a separate inlet, the ratio of fluids from each inlet as well as the total flow from both inlets can be adjusted.

Typically, the stepper motors are controlled such that once a desired flow in the intermediary pipe 55 is achieved, an adjustment to one valve is accompanied by a negative adjustment of the other, so that the mix of fluid in the intermediary pipe 55, or temperature, can be adjusted whilst the pressure is maintained. This may be modified to take account of relative differences in supply pressures that occur where non mains pressure water supply systems are used.

The servo valve system 50 also includes an outlet manifold 56 which, typically, has three final outlets such as 57 and 58, each including a solenoid valve such as 59 and 60.

One embodiment incorporating this aspect of the present invention is intended for use with a shower unit, which has two fixed shower heads, one at head height and one at mid drift height, for example. This embodiment is supplied with hot and cold water at separate inlets and includes a thermistor

inserted into the intermediary chamber 55 to provide feedback on temperature for appropriate control of the two valves such as 51. Thus, a drop in one or the other of the water supplies will be compensated in terms of temperature without the need for a pressure feedback, although this may be included if desired.

This embodiment is able to compensate for changes in supplied pressure of either or both the hot and cold water so that a constant desired temperature and constant desired pressure is provided at the shower heads. It may also compensate for changes in pressure at one or two of the final outlets such as 57 and 58 in the event that one or two of the other final outlets are opened or closed.

One preferred embodiment of the present invention is directed for use in bathroom showers where it provides relatively constant temperature water for shower heads. It will be clear to those skilled in the art that the bathroom shower is merely an example application and that many analogous applications of this embodiment exist and that the mixing of water of different temperatures may be analogous to the mixing of fluids having other physical or chemical properties. A few examples are ph, viscosity, dielectric constant, or content of a given chemical or biological agent.

The bathroom shower mixing system is supplied with two fluids, hot and cold water at given pressures. These are mixed by a servo valve system according to any of the embodiments described above and information on the temperature of the mixed fluid is fed back to the controller of the servo valve system. In the case of the servo valve system 50 being used, information on pressure can be estimated by the known position of the stepper motors and so pressure may be maintained.

The temperature sensors are typically negative temperature coefficient sensors. Some inherent nonlinearity of the temperature signals may be partially compensated with the sensor electronics before quantisation by the microprocessor. The microprocessor contains software that compares the measured temperature with a predefined reference

temperature. From this, and with an appropriate control algorithm, again, the microprocessor determines the required position of the stepper motors, and therefore, the valve members 1 and 10. It will be understood by those skilled in the art that calibration of the system will be necessary and suitable calibration will be apparent.

To maintain excellent speed and torque characteristics whilst maintaining good angular resolution and minimal microprocessor resource, the stepper motors are, preferably, operated at two speeds using two different stepping modes.

The motor is "full-stepped" for large displacements. This optimises the speed and torque response.

The motor is "half-stepped" for temperature adjustments. This optimises the resolution of movements.

The motors are half-stepped at the start of an acceleration from rest and later full-stepped. Similarly, the motors are half-stepped at the end of a deceleration to rest and after full-stepping. These measures reduce mechanical shock and overcome inertia of the motor, gearbox and valve assembly.

The mixer system also includes protection against the valve being left open in the event of loss of electrical power. Two methods are employed in the preferred embodiment. One method includes the use of batteries which store enough energy to close the valve assembly when power loss is detected. The other method includes the use of solenoids that require power to remain open and, thus the flow is shut off when the power fails.

Figure 15 shows a user interface 60 for a preferred embodiment of the bathroom shower mixing system that includes the servo valve system 50.

The user interface 60 includes an LCD display for displaying the desired and/or actual water temperature and ± 62 button system for adjusting the desired water temperature.

A set of three buttons 63 are also included to switch on/off a shower rose, perhaps, fixed at head height, shower jets, perhaps, fixed at midriff height and a hand held shower rose. The set of buttons 64 are included for user programmable preset functions for, perhaps, temperature and combinations of outlets and lights. Button 65 controls an economy mode which may reduce water flow by 25% or 50%. Button 66 may be used to set the shower duration with increments of 30 seconds. Button 67 switches on/off a "Swedish" cycle which fluctuates the shower temperature between hot and cold.

Figure 16 schematically shows the operation of a servo valve system in accordance with an embodiment of the present invention.

Information on a desired value of a given parameter, such as temperature of fluid leaving the valve system, is received from the user by the user interface 71. This information is fed to the system controller 72. The system controller 72 receives information from a sensor at the output of the valve system and includes an analog to digital converter to quantify the parameter value sensed by the sensor. The position of the stepper motor and gearbox 75 is then calculated by the module 74 and then converted to a stepper sequence by the stepper sequencer 81. The stepper motor and gearbox 75 are then driven by the stepper driver 76 to the required position. By actuation of the stepper motor and gearbox, the mixing assembly 77 is placed in a suitable position to mix the inlet fluids 78 and 79 to form the outlet fluid 80. Information on the given parameter is then fed back to the microcontroller and the process repeated by way of adjustment.

It will be apparent to those skilled in the art that an alternative embodiment to those described above may include a valve assembly 19 used in reverse where water is fed into the outlet 22 from a single supply and from there diverted into either of the conduits 2 or 3 of the, now, outlet

member.

Figures 17 to 20 show a further embodiment of the present invention. This is a combined valve provided to control temperature, pressure and also direct flow between alternative outlets. The fluid control valve 90 shown in Figures 17 to 20 may control the flow hot and cold water independently to alternative outlets. The valve 90 may comprise a main body portion 91 having hot and cold water inlets 92 and 93 respectively. Valve members 94 and 95 may be provided in cooperating pairs acting to independently control the flow of hot and cold water respectively. These cooperating pairs may be prepared as pairs of valve members in accordance with valve members 1 and 10, although it will be preferable that the inlet valve member/and outlet valve member 10 are swapped so that the "outlet" valve member 10 now communicates directly with the fluid supply.

It can be seen that the outlet from the valve members 94 and 95 allows flow into either one of two mixing chambers 96 and 97, each connected with separate outlets 98 and 99. Further, control of the valve members 94 and 95 and the relative rotation of one with the other is provided by stepper motors 100 and 101. These stepper motors may be controlled by a controller which may receive feedback information on temperature, or some other fluid parameter, at the outlet.

It can be seen that a valve of this type may be mounted on an installation to divert flow between a shower head or a bath spout, for example. The temperature at the outlet may be controlled through independent control over the flow of hot and cold fluid into the mixing chambers through the valve members 94 and 95 by control of the stepper motors 100 and 101. Furthermore, if the valve members 94 and 95 are independently controlled, the flow rate from the valve may be controlled by controlling the degree to which each of these valve members are opened.

This assembly allows servo control over the direction, flow rate and temperature fluid in a single installation.

In all the valve assemblies, filters may be incorporated either within the valve or upstream to inhibit the entry of particular matter into the valve which may affect the valve control.

Although the above described embodiments have been described in reference to the mixing of two fluids, it will be apparent to those skilled in the art that the valve or valve systems may find useful application in controlling the flow of a single fluid and that this is merely a simpler application than controlling the flow of two fluids. One possible example of a single fluid application is in the control of water supplied to a urinal. For single fluid applications, the valve member 1 described above may be used with both apertures 2 and 3 communicating with a single fluid supply. An alternative embodiment includes an inlet valve member, not shown, similar to the inlet member 1, but consisting of only one inlet aperture.

The present invention provides an effective servo valve system which can actively compensate for fluctuations in relative supply of two or more fluids. This may, for example, be desirable for shower mixers where the hot and cold water supply pressures may fluctuate due to use in another part of a building, for example.

Another embodiment of the present invention provides a servo valve system, which may actively adjust for flow or relative and absolute changes in the supply pressure of two or more supplied fluids. This may, for example, be useful for shower mixing units where constant flow as well as constant temperature is desired. This may be particularly useful where the shower mixer has multiple outlets and adjustment of supply pressure is necessary to compensate for sudden changes in outflow through the outlets.

The present invention provides servo control valve systems which incorporate stepper motors which are, by their nature, suited to servo control applications and eliminate the need for systems for monitoring the position of the valves or motors.

Where in the foregoing description, reference has been made to specific components or integers of the invention having known equivalents then such equivalents are herein incorporated as if individually set forth.

Although this invention has been described by way of example and with reference to possible embodiments thereof, it is to be understood that modifications or improvements may be made thereto without departing from the scope or spirit of the invention, as defined in the appended claims.

CLAIMS

1) A fluid control valve including:

- a valve body;
- a first member defining at least one first aperture communicating with at least one respective fluid supply or outlet;
- a second member defining at least one second aperture;
- wherein the first and second members are arranged in sealing contact and are variably alignable so that first and second apertures are, in turn, variably alignable such that fluid may flow through the at least one first aperture only when there is an overlap between first and second apertures, and such that the flow through the or each second aperture may be varied by variable alignment of the first and second apertures.

2) A fluid control valve as claimed in Claim 1, wherein the first member includes at least one sealing region suitable to facilitate sealing between the first and second members.

3) A fluid control valve as claimed in Claim 2, wherein the first member includes at least one friction reducing region consisting of an indented region to reduce the area of contact between the inlet and outlet members.

4) A fluid control valve as claimed in Claim 3, wherein the at least one friction reducing region is substantially defined by a sealing region arranged around the periphery of the first member.

5) A fluid control valve as claimed in Claim 4, wherein the at least one friction reducing region includes at least one region extending radially to the periphery of the inlet member.

6) A fluid control valve as claimed in any one of the preceding claims, wherein the or each first aperture is substantially sector shaped.

7) A fluid control valve as claimed in any one of the preceding claims, wherein the or each second aperture is substantially sector shaped.

8) A valve as claimed in any one of the preceding claims, wherein the valve is arranged such that variable alignment of the first and second members is brought about by relative rotation of the first and second members.

9) A valve as claimed in Claim 8, wherein the second member is rotatable within a cylindrical region.

10) A valve as claimed in any one of the preceding claims, wherein the second member is substantially in the form of a disk having one or more removed sector(s).

11) A valve as claimed in any one of the preceding claims, wherein the first member is substantially of the form of a disk having at least one

removed interior region.

12) A valve as claimed in any one of the preceding claims including a pipe having an internal bore into which the first member sealingly fits such that fluid is constrained to passing only through the inlet apertures.

13) A valve as claimed in any one of the preceding claims including at least one electric motor arranged to actuate the relative alignment of the first and second members.

14) A fluid control valve communicating with at least two fluid supplies, including:

- at least two valve subunits, each subunit including a first member having at least one first aperture and a second member having at least one second aperture, and wherein fluid flow from the at least one first aperture is controllable by variable alignment of the first and second members;

- at least one electric motor arranged to actuate the variable alignment of first and second members for one or more valve subunits.

15) A valve as claimed in Claims 13 or 14, wherein the at least one electric motor is a stepper motor.

16) A valve as claimed in any one of Claims 13 to 15, including at least one gear to facilitate the actuation for variable alignment of the first and second members.

17) A valve as claimed in any one of Claims 13 to 16 including a controller to control the at least one electric motor and thereby the flow from the or each of the first apertures.

18) A valve as claimed in Claim 17, wherein the controller includes a microcontroller.

19) A valve as claimed in Claim 17 or Claim 18, including at least one sensor to sense at least one parameter of the fluid(s).

20) A valve as claimed in Claim 19, wherein the controller is arranged to control the flow from the or each of the first apertures and to receive information from the at least one sensor to control at least one of the at least one parameter of fluid leaving the valve.

21) A valve as claimed in Claim 19 or Claim 20, wherein the at least one given parameter includes temperature information.

22) A valve as claimed in any one of Claims 17 to 21, wherein the controller is arranged suitably to estimate flow taking into account at least the position of the stepper motor.

23) A valve as claimed in any one of the preceding claims, including an outlet manifold having two or more manifold outlets.

24) A valve as claimed in Claim 23, wherein the one or more manifold outlets include valves to allow or prevent flow from the respective manifold outlets.

25) A valve as claimed in any one of Claims 19 to 24, including a user interface adapted to receive information on the at least one parameter of fluid leaving the valve.

26) A fluid control valve as claimed in any one of the preceding claims, including a single first aperture and at least two second apertures arranged such that variable alignment of the first and second members allows variable diversion of fluid through each of the at least two second apertures.

27) A fluid control valve including:

- at least two outlets;
- at least two fluid control valves as claimed in Claim 26, wherein one second aperture of each fluid control valve communicates with one or the other of the two outlets.

28) A valve as hereinbefore described with reference to any one of the embodiments shown in the accompanying drawings.

29) A valve assembly substantially as hereinbefore described with reference to any one of the embodiments shown in the accompanying drawings.

30) A servo valve system substantially as hereinbefore described with reference to any one of the embodiments shown in the accompanying drawings.

31) A combined mixing and diverting valve substantially as hereinbefore described with reference to Figures 17 to 20.

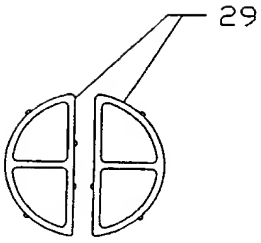


Figure 10

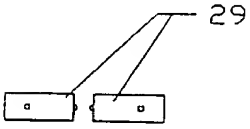
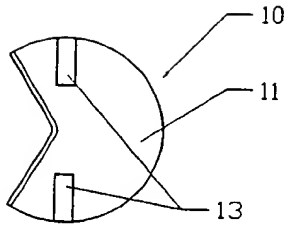


Figure 10a



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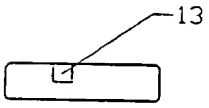


Figure 4

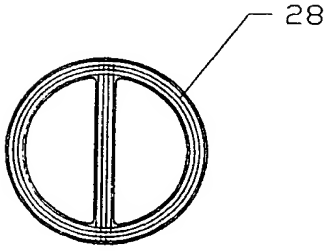


Figure 9

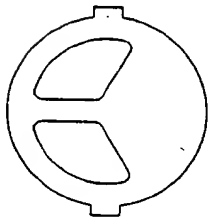


Figure 5

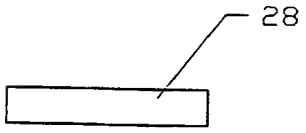


Figure 9a

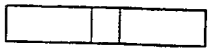


Figure 6

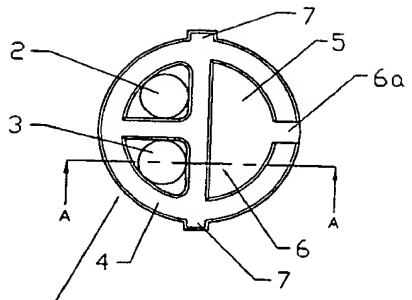


Figure 1

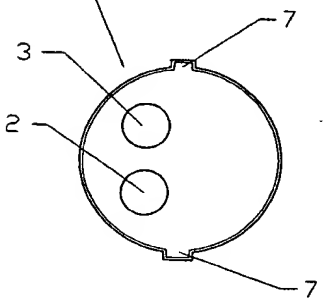


Figure 1a

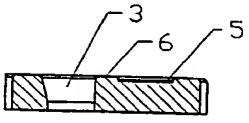


Figure 2

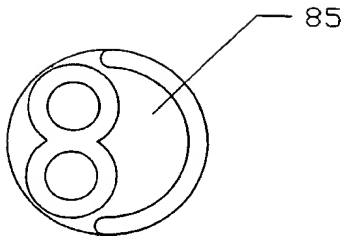


Figure 7

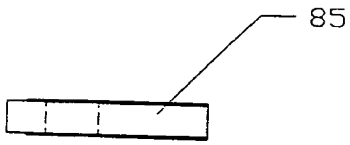


Figure 8

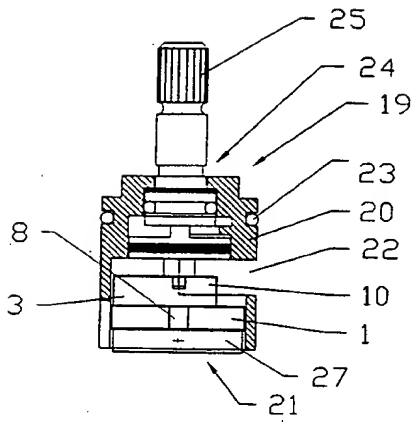


Figure 11

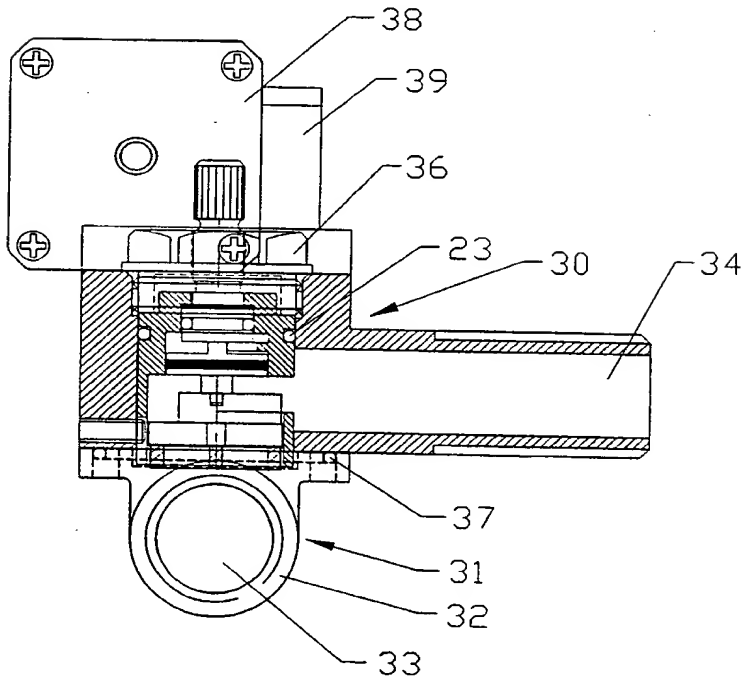


Figure 12

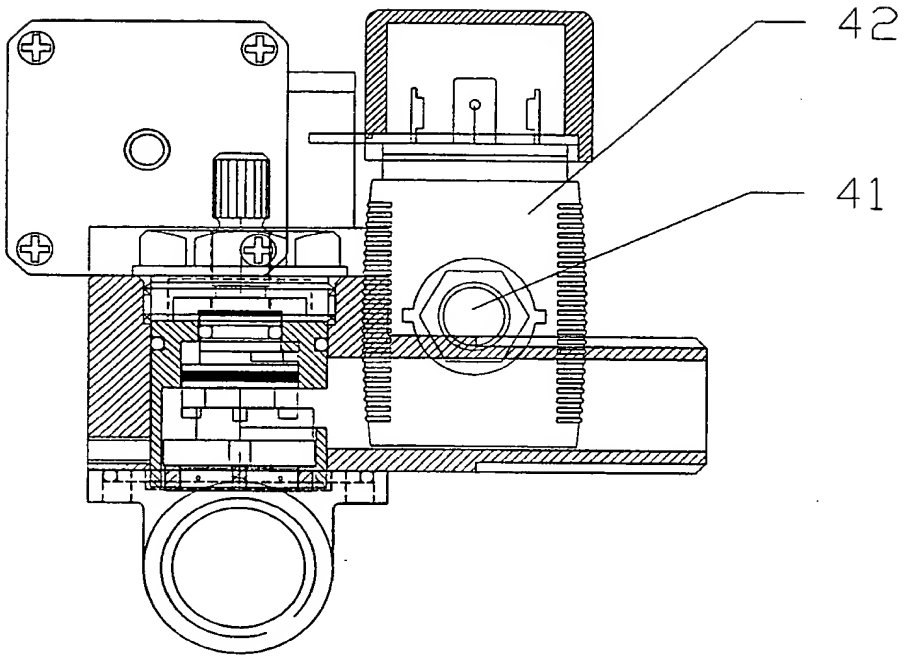


Figure 13

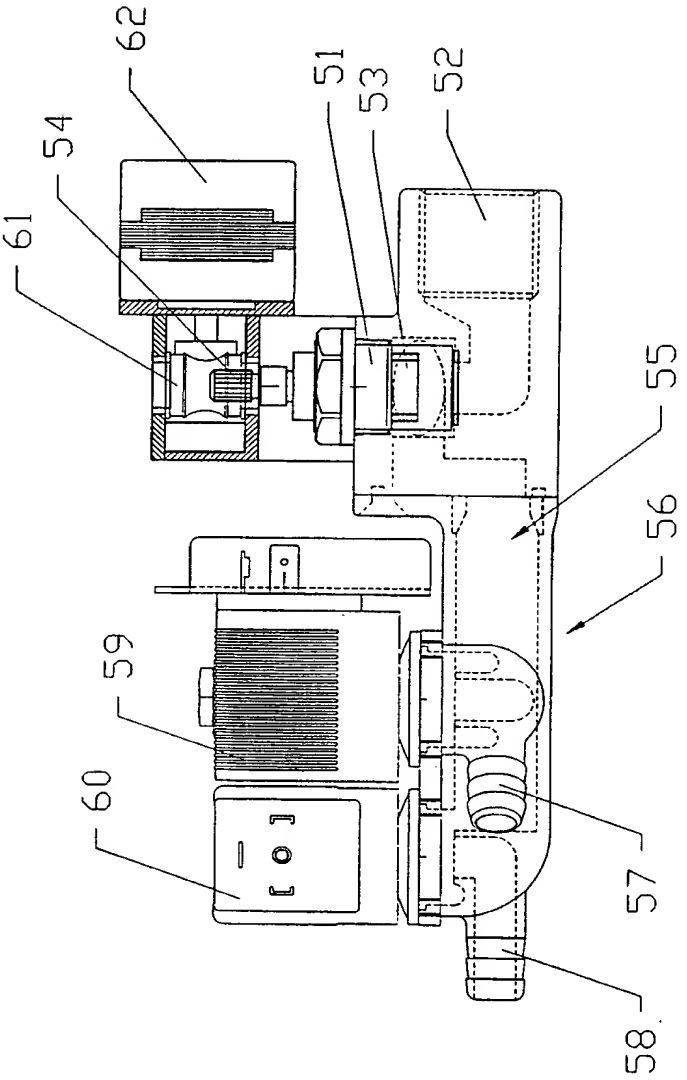
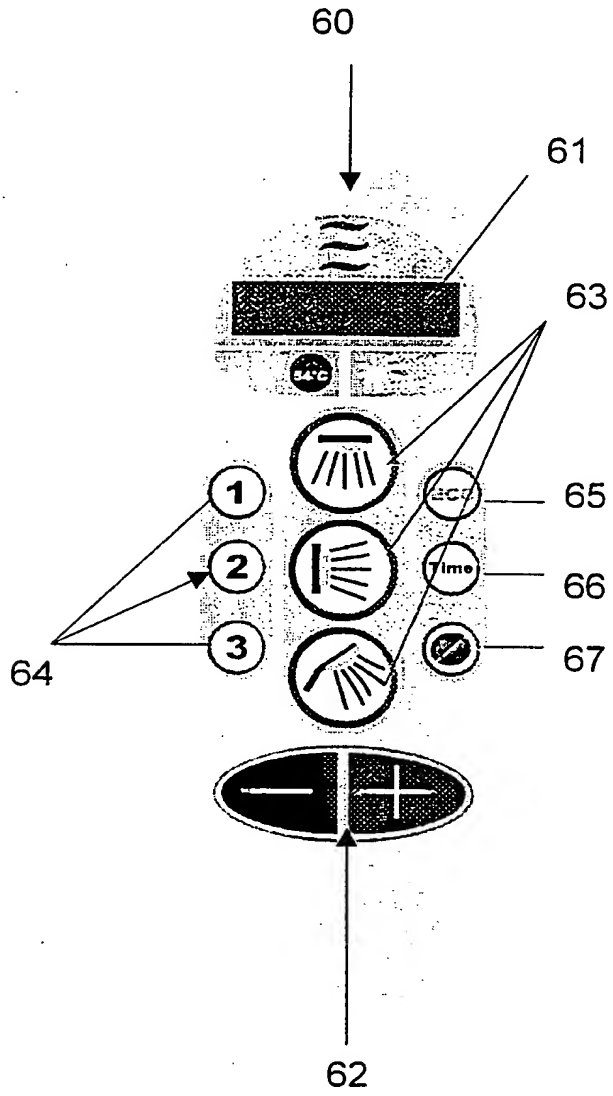


Figure 14

Fig 15



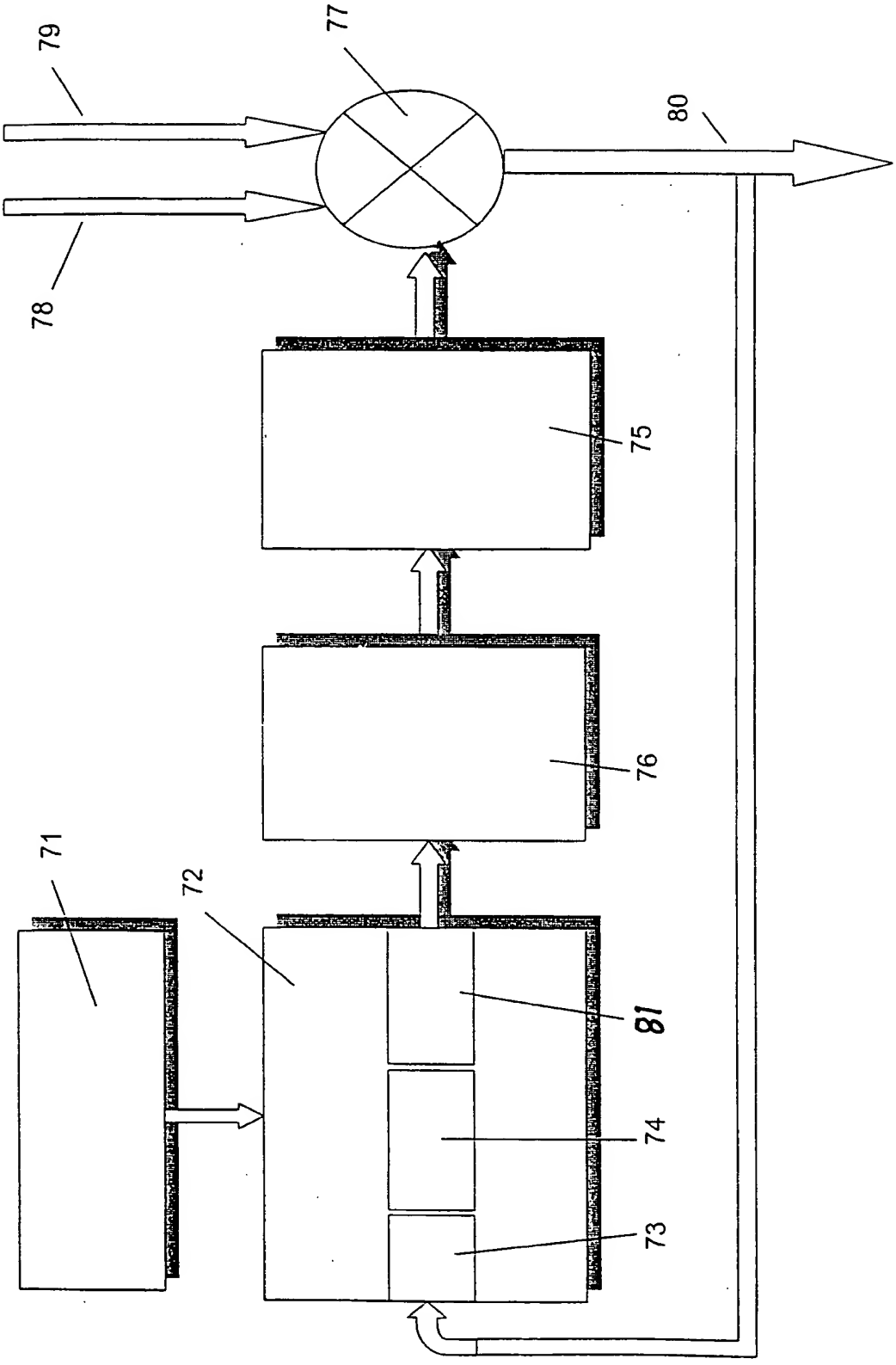


Figure 16

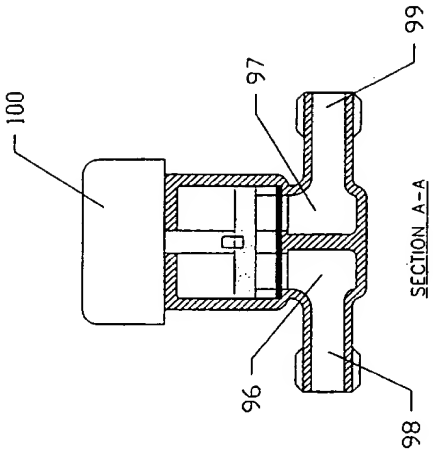


Figure 18

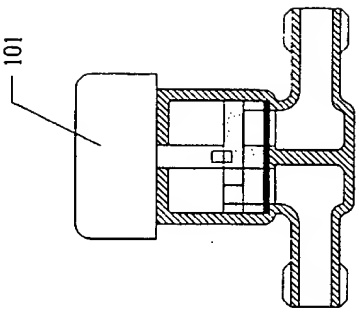


Figure 20

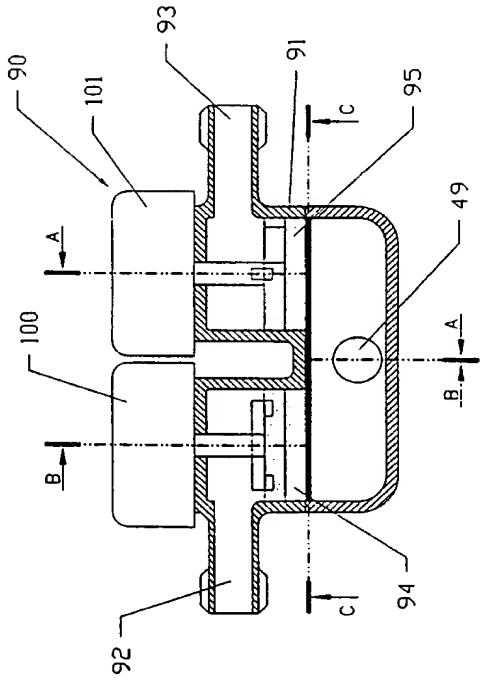


Figure 17

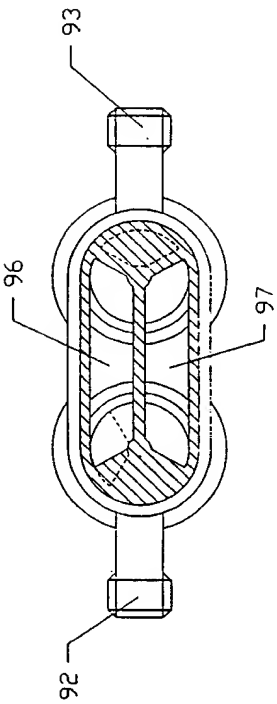


Figure 19

INTERNATIONAL SEARCH REPORT

International application No.
PCT/NZ97/00168

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :G05D 23/12
US CL :236/12.12, 12.15; 251/129.11
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 236/12.12, 12.15; 251/129.11, 301, 304

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

None

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

None

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 3,363,536 A (DEAN, JR.) 16 January 1968, column 2, lines 58-72.	1, 2 --- 3-6 and 14
Y	US 3,810,602 A (PARKINSON) 14 May 1974, column 5, line 59 to column 6, line 64.	3-6 and 14
A	US 5,417,083 A (EBER) 23 May 1995, see the entire document.	1-6 and 14
A	5,014,748 A (NOGAMI ET AL) 14 May 1991, see the entire document.	1-6 and 14
A	US 4,889,315 A (IMANAGA) 26 December 1989, see the entire document.	1-6 and 14
A	US 4,700,885 A (KNEBEL) 20 October 1987, see the entire document.	1-6 and 14

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search	Date of mailing of the international search report
03 MARCH 1998	16 APR 1998
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer WILLIAM E. TAPOLCAI Telephone No. (703) 308-2640

Form PCT/ISA/210 (second sheet)(July 1992)*

INTERNATIONAL SEARCH REPORT

International application No.
PCT/NZ97/00168

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4,558,817 A (KIENDL) 17 December 1985, see the entire document.	1-6 and 14

INTERNATIONAL SEARCH REPORT

International application No.
PCT/NZ97/00168

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☒ Claims Nos.: 28-31
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

they are omnibus claims that are indefinite because they fail to point out what is included or excluded by the claim language.

3. ☒ Claims Nos.: 7-13 and 15-27
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.